WHAT IS CLAIMED IS:

1. A data recording apparatus for recording data on a recording medium, comprising:

modulation encoding means for applying predetermined modulation encoding to input data; and

interleaving means for interleaving data supplied from said modulation encoding means for re-arraying the data sequence.

2. The data recording apparatus according to claim 1 further comprising:

precoding means for filtering data supplied from said interleaving means to compensate for channel characteristics.

3. The data recording apparatus according to claim 1 further comprising:

error correction coding means for applying error correction coding to the input data;

said modulation encoding means modulation encoding the data supplied from said error correction coding means.

4. The data recording apparatus according to claim 1 wherein said modulation encoding means encodes input data in accordance with a constraint condition.

5. The data recording apparatus according to claim 4 wherein said interleaving means interleaves data encoded by said modulation encoding means so that said constraint condition is satisfied.

6. The data recording apparatus according to claim 4 wherein said modulation encoding means encodes the input data by block modulation.

7. The data recording apparatus according to claim 6 wherein said interleaving means interleaves data encoded by said modulation encoding means in terms of a modulation encoding block as a unit.

8. The data recording apparatus according to claim 4 wherein said modulation encoding means encodes input data in accordance with a trellis conforming to said constraint condition.

9. The data recording apparatus according to claim 8 wherein said interleaving means interleaves data encoded by said modulation encoding means in terms of a modulation encoding block of said trellis as a unit.

10. The data recording apparatus according to claim 1 wherein data is recorded on said recording medium in a magnetic, optical or magneto-optical system.

11. A data recording method for recording data on a recording medium, comprising the steps of:

applying predetermined modulation encoding to input data; and

interleaving the modulation-encoded data supplied from said modulation encoding step for re-arraying the data sequence.

12. The data recording method according to claim 11 further comprising:

filtering the interleaved modulation-encoded data to compensate for channel characteristics.

13. The data recording method according to claim 11 wherein said input data is error correction coded data.

14. The data recording method according to claim 11 wherein said step of applying encodes input data in accordance with a constraint condition.

15. The data recording method according to claim 14 wherein said step of interleaving interleaves the modulation-encoded data so that said constraint condition is satisfied.

16. The data recording method according to claim 14 wherein said step of applying encodes the input data by block modulation.

17. The data recording method according to claim 16 wherein said step of interleaving the modulation-encoded data in terms of a modulation encoding block as a unit.

18. The data recording method according to claim 14 wherein said step of applying encodes input data in accordance with a trellis conforming to said constraint condition.

19. The data recording method according to claim 18 wherein said step of interleaving interleaves the modulation-encoded data in terms of a modulation encoding block of said trellis as a unit.

20. The data recording method according to claim 11 wherein data is recorded on said recording medium in a magnetic, optical or magneto-optical system.

21. A data reproducing apparatus for reproducing data recorded by a recording equipment for recording data on a recording medium, the recording equipment including modulation encoding means for applying predetermined modulation encoding to input data and first interleaving means for interleaving data supplied from

said modulation encoding means for re-arraying the data sequence, said data reproduction apparatus comprising:;

deinterleaving means for interleaving reproduced data in its sequence such as to restore the sequence of data bits re-arrayed by said first interleaving means to the bit sequence of the data as encoded by said modulation encoding means;

modulation decoding means for modulation decoding the data supplied from said deinterleaving means; and

second interleaving means for interleaving data corresponding to a difference between data output by said modulation decoding means and data output by said deinterleaving means, based on the same interleaving position information as that of said first interleaving means, for re-arraying the sequence of the difference data.

22. The data reproducing apparatus according to claim 21 wherein said modulation decoding means is fed with a soft input signal and outputs a soft output signal.

23. The data reproducing apparatus according to claim 21 wherein said recording equipment includes precode means for filtering data supplied from said first interleaving means to compensate for channel characteristics, and the data reproducing apparatus further comprising:

channel decoding means for decoding the channel response.

24. The data reproducing apparatus according to claim 23 wherein said channel decoding means is fed with a soft input signal and effects soft output decoding.

25. The data reproducing apparatus according to claim 23 wherein said channel

decoding means is fed with a soft input signal and effects soft output decoding based on a trellis corresponding to the channel response.

26. The data reproducing apparatus according to claim 24 wherein said deinterleaving means interleaves data corresponding to difference between the data output by said channel decoding means and data output from said second interleaving means;

decoding being iteratively performed between said modulation decoding means and said channel decoding means.

27. The data reproducing apparatus according to claim 26 wherein said recording equipment includes error correction encoding means for error correction encoding input data to supply the resulting data to said modulation encoding means, and the data reproducing apparatus further comprising;

error correcting soft decoding means for soft decoding the error correction code of the soft input signal corresponding to soft output data obtained by said modulation decoding means as a result of iterative decoding.

28. The data reproducing apparatus according to claim 21 wherein said modulation encoding means encodes the input data in accordance with a constraint condition;

said modulation decoding means effecting decoding conforming to said constraint condition.

29. The data reproducing apparatus according to claim 28 wherein said first interleaving means interleaves data encoded by said modulation encoding means.

30. The data reproducing apparatus according to claim 28 wherein said modulation

encoding means encodes the input data by block modulation.

31. The data reproducing apparatus according to claim 30 wherein said modulation decoding means includes likelihood calculating means for calculating the likelihood value corresponding to each output codeword output by said modulation encoding means, wherein

the posterior probability information as a soft decision value for an input bit to said modulation encoding means and an output bit from said modulation encoding means being calculated using said likelihood value as calculated by said likelihood calculating means.

32. The data reproducing apparatus according to claim 30 wherein said modulation decoding means effects decoding based on a trellis corresponding to said constraint condition.

33. The data reproducing apparatus according to claim 30 wherein said first interleaving means interleaves data encoded with block modulation by said modulation encoding means in terms of a modulation encoding block as a unit.

34. The data reproducing apparatus according to claim 28 wherein said modulation encoding means encodes input data in accordance with said trellis conforming to said constraint condition;

said modulation decoding means effecting decoding based on a trellis conforming to said constraint condition.

35. The data reproducing apparatus according to claim 34 wherein said first

interleaving means interleaves data encoded by said modulation encoding means in terms of a modulation encoding block of said trellis as a unit.

36. The data reproducing apparatus according to claim 22 wherein said modulation decoding means effects soft output decoding based on the BCJR algorithm or on the SOVA algorithm.

37. The data reproducing apparatus according to claim 21 wherein data is recorded on said recording medium by a magnetic, optical or magneto-optical system.

38. A data reproducing method for reproducing data recorded by a recording method for recording data on a recording medium including a modulation encoding step of applying predetermined modulation encoding to input data and a first interleaving step of interleaving data encoded in said modulation encoding step, for re-arraying the data sequence, said data reproduction method comprising the steps of:

deinterleaving the input data in its sequence such as to restore the sequence of data bits re-arrayed by said first interleaving step to the bit sequence of the data as encoded by said modulation encoding step;

modulation decoding the data supplied from said step of deinterleaving; and

interleaving data corresponding to a difference between data decoded in said modulation encoding step and data re-arrayed in said step of deinterleaving, based on the same interleaving position information as that of said first interleaving step, for re-arraying the sequence of the difference data.

39. The data reproducing method according to claim 38 wherein said step of

modulation decoding is fed with a soft input signal and outputs a soft output signal.

40. The data reproducing method according to claim 38 wherein said recording method includes a precode step of filtering data supplied from said first interleaving step to compensate for channel characteristics, and the data reproducing method further comprising:

channel decoding the channel response.

41. The data reproducing method according to claim 40 wherein said step of channel decoding is fed with a soft input signal and effects soft output decoding.

42. The data reproducing method according to claim 40 wherein said step of channel decoding is fed with a soft input signal and effects soft output decoding based on a trellis corresponding to the channel response.

43. The data reproducing method according to claim 41 wherein said step of deinterleaving interleaves data corresponding to difference between the data decoded in said step of channel decoding and data re-arrayed in said step of interleaving;

decoding being iteratively performed between said step of modulation decoding and said step of channel decoding.

44. The data reproducing method according to claim 43 wherein said recording method includes an error correction encoding step of error correction encoding input data to supply the resulting data to said modulation encoding step, and the data reproducing method further comprising:

soft decoding the error correction code of the soft input signal corresponding

to soft output data obtained by said modulation decoding step as a result of iterative decoding.

45. The data reproducing method according to claim 38 wherein said modulation encoding step encodes the input data in accordance with a constraint condition;

said step of modulation decoding effects decoding conforming to said constraint condition.

46. The data reproducing method according to claim 45 wherein said first interleaving step interleaves data encoded by said modulation encoding step so that the constraint condition is satisfied.

47. The data reproducing method according to claim 45 wherein said modulation encoding step encodes the input data by block modulation.

48. The data reproducing method according to claim 47 wherein said step of modulation decoding includes a likelihood calculating step of calculating the likelihood value of each output codeword generated and output by said modulation encoding step;

the posterior probability information as a soft decision value for an input bit to said modulation encoding step and an output bit from said modulation encoding step being calculated using said likelihood value as calculated by said likelihood calculating step.

49. The data reproducing method according to claim 47 wherein said modulation decoding step effects decoding based on a trellis corresponding to said constraint

condition.

50. The data reproducing method according to claim 47 wherein said first interleaving step interleaves data encoded with block modulation by said modulation encoding step in terms of a modulation encoding block as a unit.

51. The data reproducing method according to claim 45 wherein said modulation encoding step encodes input data in accordance with the trellis conforming to said constraint condition;

said step of modulation decoding effects decoding based on a trellis conforming to said constraint condition.

52. The data reproducing method according to claim 51 wherein said first interleaving step interleaves data encoded by said modulation encoding step in terms of a modulation encoding block of said trellis as a unit.

53. The data reproducing method according to claim 39 wherein said step of modulation decoding effects soft output decoding based on the BCJR algorithm or on the SOVA algorithm.

54. The data reproducing method according to claim 38 wherein data is recorded on said recording medium by a magnetic, optical or magneto-optical system.

55. A data recording and reproducing apparatus for recording and reproducing data for a recording medium, said apparatus comprising

modulation encoding means for applying predetermined modulation encoding to input data;

first interleaving means for interleaving data supplied from said modulation encoding means for re-arraying the data sequence;

deinterleaving means for interleaving reproduced data in its sequence such as to restore the sequence of data bits re-arrayed by said first interleaving means to the bit sequence of the data as encoded by said modulation encoding means;

modulation decoding means for modulation decoding the data supplied from said deinterleaving means; and

second interleaving means for interleaving data corresponding to a difference between data output by said modulation decoding means and data output by said deinterleaving means, based on the same interleaving position information as that of said first interleaving means, for re-arraying the sequence of the difference data.

56. The data recording and reproducing apparatus according to claim 55 wherein said modulation decoding means is fed with a soft input signal and outputs a soft output signal.

57. The data recording and reproducing apparatus according to claim 55, further comprising:

precode means for filtering data supplied from said first interleaving means to compensate for channel characteristics, and

channel decoding means for decoding the channel response.

58. The data recording and reproducing apparatus according to claim 57 wherein said channel decoding means is fed with a soft input signal and effects soft output

decoding.

59. The data recording and reproducing apparatus according to claim 57 wherein said channel decoding means is fed with a soft input signal and effects soft output decoding based on a trellis corresponding to the channel response.

60. The data recording and reproducing apparatus according to claim 58 wherein said deinterleaving means interleaves data corresponding to difference between the data output by said channel decoding means and data output from said second interleaving means;

decoding being iteratively performed between said modulation decoding means and said channel decoding means.

61. The data recording and reproducing apparatus according to claim 60, further comprising:

error correction encoding means for error correction encoding input data, wherein said modulation encoding means modulation encodes data supplied from said error correction encoding means; and

error correcting soft decoding means for soft decoding the error correction code of the soft input signal corresponding to the soft output data obtained by said modulation decoding means as a result of iterative decoding.

62. The data recording and reproducing apparatus according to claim 55 wherein said modulation encoding means encodes the input data in accordance with a constraint condition;

said modulation decoding means effects decoding conforming to said constraint condition.

63. The data recording and reproducing apparatus according to claim 62 wherein said first interleaving means interleaves data encoded by said modulation encoding means.

64. The data recording and reproducing apparatus according to claim 62 wherein said modulation encoding means encodes the input data by block modulation.

65. The data recording and reproducing apparatus according to claim 64 wherein said modulation decoding means includes likelihood calculating means for calculating the likelihood value corresponding to each output codeword output by said modulation encoding means;

the posterior probability information as a soft decision value for an input bit to said modulation encoding means and an output bit from said modulation encoding means being calculated using said likelihood value as calculated by said likelihood calculating means.

66. The data recording and reproducing apparatus according to claim 64 wherein said modulation decoding means effects decoding based on a trellis corresponding to said constraint condition.

67. The data recording and reproducing apparatus according to claim 64 wherein said first interleaving means interleaves data encoded with block modulation by said modulation encoding means in terms of a modulation encoding block as a unit.

68. The data recording and reproducing apparatus according to claim 62 wherein said

modulation encoding means encodes input data in accordance with said trellis conforming to said constraint condition;

said modulation decoding means effects decoding based on a trellis conforming to said constraint condition.

69. The data recording and reproducing apparatus according to claim 68 wherein said first interleaving means interleaves data encoded by said modulation encoding means in terms of a modulation encoding block of said trellis as a unit.

70. The data recording and reproducing apparatus according to claim 56 wherein said modulation decoding means effects soft output decoding based on the BCJR algorithm or on the SOVA algorithm.

71. The data recording and reproducing apparatus according to claim 55 wherein data is recorded on said recording medium by a magnetic, optical or magneto-optical system.

72. A data recording and reproducing method for recording and reproducing data for a recording medium, said method comprising the steps of:

applying predetermined modulation encoding to input data;

interleaving the modulation-encoded data for re-arraying the data sequence;

deinterleaving reproduced data in its sequence such as to restore the sequence of data bits re-arrayed by said step of interleaving to the bit sequence of the modulation-encoded data;

modulation decoding the data supplied from said step of deinterleaving; and

interleaving data corresponding to a difference between data decoded in said step of modulation decoding and data re-arrayed in said step of deinterleaving based on the same interleaving position information as that of said step of interleaving the modulation-encoded data.

73. The data recording and reproducing method according to claim 72 wherein said step of modulation decoding is fed with a soft input signal and outputs a soft output signal.

74. The data recording and reproducing method according to claim 72, further comprising:

filtering data supplied from said step of interleaving the modulation-encoded data to compensate for channel characteristics, and

channel decoding the channel response.

75. The data recording and reproducing method according to claim 74 wherein said step of channel decoding is fed with a soft input signal and effects soft output decoding.

76. The data recording and reproducing method according to claim 74 wherein said step of channel decoding is fed with a soft input signal and effects soft output decoding based on a trellis corresponding to the channel response.

77. The data recording and reproducing method according to claim 76 wherein said step of deinterleaving interleaves data corresponding to data between the data output by said step of channel decoding and data output from said step of interleaving the

difference data;

decoding being iteratively performed between said step of modulation decoding and said step of channel decoding.

78. The data recording and reproducing method according to claim 77, further comprising:

error correction encoding input data, wherein said applying modulation encodes data supplied from said step of error correction encoding; and

soft decoding the error correction code of the soft input signal corresponding to the soft output data obtained by said step of modulation decoding as a result of iterative decoding.

79. The data recording and reproducing method according to claim 72 wherein said step of applying encodes the input data in accordance with a constraint condition;

said step of modulation decoding effects decoding conforming to said constraint condition.

80. The data recording and reproducing method according to claim 79 wherein said step of interleaving the modulation-encoded data interleaves the modulation-encoded data so that the constraint condition is satisfied.

81. The data recording and reproducing method according to claim 79 wherein said step of applying encodes the input data by block modulation.

82. The data recording and reproducing method according to claim 81 wherein said modulation decoding step includes a likelihood calculating step for calculating the

likelihood value corresponding to each output codeword output by said modulation encoding step,

the posterior probability information as a soft decision value for an input bit to said step of applying and an output bit from said step of applying being calculated using said likelihood value as calculated by said likelihood calculating step.

83. The data recording and reproducing method according to claim 81 wherein said step of modulation decoding effects decoding based on a trellis corresponding to said constraint condition.

84. The data recording and reproducing method according to claim 81 wherein said step of interleaving the modulation-encoded data interleaves the modulation-encoded data in terms of a modulation encoding block as a unit.

85. The data recording and reproducing method according to claim 79 wherein said step of applying encodes input data in accordance with the trellis conforming to said constraint condition;

said step of modulation decoding effects decoding based on a trellis conforming to said constraint condition.

86. The data recording and reproducing method according to claim 85 wherein said step of interleaving the modulation-encoded data interleaves the modulation-encoded data in terms of a modulation encoding block of said trellis as a unit.

87. The data recording and reproducing method according to claim 73 wherein said modulation decoding step effects soft output decoding based on the BCJR algorithm

or on the SOVA algorithm.

88. The data recording and reproducing method according to claim 72 wherein data is recorded on said recording medium by a magnetic, optical or magneto-optical system.